# Outline for a

# Reading Course

on

# Cyclopedia of Drawing

AMERICAN TECHNICAL SOCIETY
CHICAGO U. S. A.

# Outline for a
# Reading Course
on
# Cyclopedia of Drawing

Prepared especially for the instruction and training
of the members of the
American Technical Society

American Technical Society
Chicago U.S.A.

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# OUTLINE FOR A READING COURSE
## on
# CYCLOPEDIA OF DRAWING

TODAY competition between manufacturing concerns is keener than ever before. The plant that is best equipped and best fitted to do its work gets the orders. And such a plant offers greater opportunities to the well-informed and more intelligent workmen.

The man who is best trained gets the best job. Today the prizes in industry are won by the men who know what to do and why, and have the necessary ability to put this knowledge into practice.

### A Short Cut in Training

IN THESE days of short cuts in production, in construction, in transportation, in nearly every type of work, what could be more reasonable than a short cut in training? For thirty odd years, the American Technical Society has been working out ways and means of short-cutting training. The Society has developed several Self-Quiz Reading Courses consisting of text material, a Consulting Membership in the Society, and a final examination for those who desire to take it.

When you have finished this Reading Course on Drawing, you will have made a real step forward. You may go on to another Reading Course, as the Society has prepared thirteen different Reading Courses on various subjects and there is no end of other good inspirational and practical texts. The man who stops reading, who stops learning, is not even standing still; he is "slipping"—going backward—because others are studying and going ahead.

### A Return of $1500

A RECENT check-up of the salary increases of two hundred members of the Society, six to eight months after their enrollment and before many of them had completed their Reading Course, showed that over half of those studying had substantially

increased their income in the same shop or factory where they had been working. One of these men received an increase of 100 per cent; he had doubled his income in less than a year. This man was getting $125 per month when he began this Reading Course, his investment netted him, therefore, $1500 a year.

It pays to study or read regularly day after day. It is better to read from fifteen to thirty minutes every day than it is to study or read four or five hours at a stretch and then do nothing for a week. Get the habit of reading, because that is what studying is, and you will soon find that your reading will be a pleasure and your advancement sure.

## What Is Training?

EXACTLY what is training? And how can you get it? Training is made up of knowledge and experience. Knowledge is acquired by study; experience is acquired by practice. Therefore, since training is obtained by putting knowledge into practice, the first step toward getting training is to acquire a knowledge of how to go about a thing; once you have that knowledge, you are in a position to get the skill that only practice can give. No one else can give you skill—that is acquired by your own effort, through constant practice; but we can show you how to acquire the knowledge that you put into practice.

**Success and Physical Condition.** We realize that you will have to carry on much of your study or reading after a hard day's work, and therefore the matter of health is exceedingly important. In keeping fit, sleep is a matter of first importance, and, while no fixed rules can be laid down with regard to the number of hours of sleep you should get in twenty-four hours, an effort should be made to get seven or eight hours of sleep every day in order that your body and mind may be prepared for the next day's task.

Perhaps you do not have to worry very much about the matter of exercise, but if you are working in any confined occupation—such as office work—you will need physical exercise if you are to keep fit. If it is impossible for you to get time for outdoor exercise, fifteen minutes a day given to systematic exercise will also do wonderful things for you in the way of keeping physically fit.

**Place to Read.** If possible, select a room apart from the chance of interference in your reading by the other members of the household, and secure a desk or a table which you can call your study desk and use it always for this purpose. This may seem a

trifling detail to you, but it is a very important matter. If you drop into an easy chair with the distractions of family or friends' conversation ever evident, you will not be able to do much serious reading. Therefore, a place which you can keep rather sacred for this purpose is one of the most important things in forming right reading habits.

If you do not have a study room, it may be physically impossible for you to shut off the outside noises from crowding in on your consciousness. If such is the case, do not worry or throw down your books and say, "It can't be done." The first day in a new job had many distractions for you, but after the first week all the noises and other disturbing things no longer worried you, because your interest in your work was more intense than your interest in these other things. The same situation will develop in your studies. You can shut out the outside disturbing elements if your heart is in your work.

**Learn to Concentrate.** You can learn to make spare time study effective only when you have learned how to concentrate on your books. The ability to concentrate on the matter in hand, once acquired, will enable you to study or work effectually anywhere, under any circumstances.

**Kind of Light.** The lighting conditions of your room are also important. You should not face a bright wall or the direct light from a window. A small light throwing the complete table or desk into illumination is better than a large light coming from above. Be sure that your light comes over your left shoulder (if you are right handed), as this will give a light without causing bad shadows.

**Temperature.** Be careful, especially in the wintertime, about working in a room that is too warm. After a hard day's work, the effect of a good supper and a stuffy, warm room will cause even the strongest-willed person to daydream if it does not actually succeed in putting him to sleep. Get a thermometer and try to keep the temperature of your room somewhere between 68 and 70 degrees.

## Fifteen Minutes a Day

OUT of your own spare time, put aside fifteen minutes each day, and label it "Hands Off! For Reading Only!" It is possible that, at first, you may have some difficulty in keeping your study period free from interruptions, but when you're

setting about so important a business as getting ahead in the world, you have the right to ask other people not to "butt in" on you.

When reading in the evening, especially after a hard day, the matter of fatigue must be given some consideration. If you feel that you are tiring rapidly and find concentration hard, get up and stretch, open your windows for a period of three or four minutes, exercise, and breathe deeply and slowly. This break in your line of thought will give you the mental rest you need, and the "stunts" will help the circulation of the blood.

## How to Make Your Reading Count

YOU must read in order **to know** or **to learn how to do.** Therefore, there are several important things you must do when reading your text for the purpose of gaining knowledge or learning how to do something.

**Read Thoroughly.** In the beginning don't skip, read every word. Later you will get the skill of reading rapidly.

**Stop and Think as You Read.** The beginning of this paragraph is a sentence. A sentence always has a thought in it. The beginning of this paragraph says something. It tells you to think as you read. Therefore, when you see a period, you know that something has been said, and you want to know clearly what was said. So in order not to lose anything that was said, keep asking yourself this question at the end of each sentence, "What does this sentence mean?" And if you can't answer your question as you continue reading the other sentences, go back to the one you can't understand and stay with it until you have found out what it means. That is the only way you can read meaning into new things. If you don't understand a word, get the dictionary.

**Get the Dictionary Habit.** Don't leave any word until you have squeezed the idea out of it. Build up a list of the new words you are meeting in your study; become thoroughly acquainted with them; seize every opportunity to put them into use in your conversation.

**Opening a Reading Period.** Do not start exactly where you left off at the close of a previous study period. Instead go back and pick up the connecting thought. You will find that your progress will be more rapid if you follow this plan of doing a little review work during each reading period. Remember the

power to get new facts depends upon the background you already have, and, therefore, the review is as important as the new facts.

**Closing a Reading Period.** When you stop your reading for the day, try to make a natural break—that is, finish some particular section of work—and then put in a book mark so it will be easy to find your place quickly. This is very important for the student who can give only odd hours to his reading.

**Developing Interest.** One of the surest ways of developing interest in your studies is to try to find out as many new things about the subject as possible. The more you know about the subject, the more interesting it becomes; therefore use every chance to discuss what you are doing with other people who know something about it. Don't wait for the chance to show your new abilities. Search for opportunities. You can do all this without making yourself obnoxious, if you use some good common sense. Also search for every opportunity to put your new knowledge to use, as this will keep your interest in your studies strong.

**Seizing Little Opportunities.** The point to keep always in mind is this: you must not expect to accomplish too much at once. Each time you add one little idea to your store of knowledge or successfully handle one little problem, you have advanced one step nearer to the efficiency of the trained man. And you must be content to advance step by step, because this is the only method possible to you. You are familiar with the saying, "Take care of the dimes, and the dollars will take care of themselves." It is just as true that, if you take care of the little opportunities for gaining or applying knowledge, the big opportunities will take care of themselves, because they are made up of little opportunities.

## Outline for Reading

### How to Start

NO DOUBT there are some subjects you are more interested in than others, and, consequently, you are eager to get at them in the beginning of your reading. The easiest way to find them is through a study of the titles found on the "backbone" of each book, as they will give you an idea of what each volume contains. The next step is to refer to the Table of Contents, which immediately follows the Foreword in the beginning of each volume, for here you will find a more thorough listing of the subjects. However, as you may desire some certain specific information in order to make a real study of the material, this may not quite meet your needs, and, therefore, you will find at the back of each volume a handy Index, which gives a more detailed classification of the subjects than the Table of Contents does, and at the same time contains direct page references.

A standard work like the Cyclopedia of Drawing covers the material one would find in a technical course on this subject. Therefore, the books contain a certain amount of material which we would classify as advanced, and another section which we might classify as strictly elementary.

In approaching this work for reading purposes, therefore, you must decide to which class of readers you belong; whether you may be considered a good draftsman or a beginner—this decision depending very largely upon your previous education and experience. If you have not had some previous training in drawing or high school work, we suggest that you do not start with any of the advanced subjects, but rather make a beginning with the elementary principles of drafting work.

### Suggested Examples in Drawing

At the end of each paragraph covering the discussion of the subjects to be studied, you will find the suggestion that certain illustrations contained in that section be drawn for practice. It is also suggested that these examples be drawn twice the size of the illustration.

# MECHANICAL DRAWING

## Volume I, Pages 11-225

A DRAFTSMAN cannot do neat or accurate work without a good set of instruments to work with. As speed is a large factor in the cost of making drawings, the draftsman must be able to work fast, and to do this he must be proficient in the handling of the instruments, and this proficiency comes only with practice. First learn how to draw lines with the T-square alone, and then with the T-square and triangles in conjunction with one another. Notice how the compass is held and how it is made to revolve with the fingers. Care should be used in drawing circles so that large holes are not made in the paper by the point of the compass needle. Accuracy in laying out the work calls for care in laying off dimensions, and two methods of doing this are given in this first section.

Curved lines which cannot be drawn with the compass can be drawn with the French curve but it takes considerable practice to draw smooth, neat curves with this instrument.

### Before Trying to Work the Following Exercises Read Mechanical Drawing, Vol. I, pp. 11-36

1. **Draw a square 6″x6″ using the T-square and one triangle.**
2. **Draw a circle inside this square so that it touches all four sides neatly.** This circle should not overlap the side neither should it fall short of the side, it should just touch the side.
3. **Draw a square 6″x6″ and then across this square draw lines at an angle of 45° using the T-square and 45° triangle. Next draw another square of the same size but in this case use the 60° triangle to draw the lines across the square.** In doing this work space the lines as evenly as possible. If you wish to lay the lines out accurately along the edges of the square, practice the use of laying them off with the scale, and then with the dividers, as explained in this section.
4. **Draw a number of circles of different sizes, all having the same center and see if you can do it without making a very large hole in the drawing paper.**
5. **Practice drawing the joining of different shaped curved lines with the French curve as shown on page 35.**
6. **Lay off the following angles with the protractor at 50°—40°—35°—95° to a horizontal line and also to a vertical line.** The method of doing this is explained in Figs. 45 and 46 of this section.

NOTE.—For page numbers, see foot of pages.

## LETTERING

### Volume I, Pages 37-48

DRAWINGS that are otherwise neatly done are often spoiled by poor lettering. A draftsman should be able to letter rapidly as well as neatly, and there is no other branch of drawing that calls for more practice, before proficiency is gained, than does the art of lettering. Lettering is mostly done freehand, and it should be uniform in size or height, according to the type and style of lettering used, and also be uniform in slope. The use of horizontal and slant guide lines will do much in training a student to get this uniformity which makes the lettering look neat. Horizontal guide lines should be constantly used, while slant guide lines should be used until the student or beginner gets a uniformity of slope.

Notice the position of the hand and fingers when holding the pen. Learn to distinguish between lowercase and capital letters, and when you have found a pen that suits your hand, stick to that pen.

### Before Trying to Work the Following Exercises Read Lettering, Vol. I, pp. 37-48

1. **Draw up a number of practice lettering forms to the same size as shown in Fig. 13 of this section with the aid of the T-square and triangle.** To draw the slant guide lines use the 30° triangle and 45° triangle in conjunction with each other, and the T-square as shown in Fig. 11 in the section on Instruments and Materials. These triangles should be placed in the reverse position to that shown in Fig. 11 of the first section, or so that the drawing edge of the 45° triangle is to the left instead of to the right as shown in the figure.

2. **Print the alphabet first in capitals and then in lowercase letters several times.**

3. **Print the following sentence first in capitals and then in lowercase letters. "The quick brown fox jumps over the lazy dog."** This sentence contains every letter of the alphabet and will give you good practice in the spacing of the words and the letters in the words.

4. **Print the numerals 0 to 9 several times. Print fractions such as 1/4, 3/8, 5/16, 3/32, etc. Print whole numbers with fractions such as 4⅝".** In printing this type of dimension keep the numerals in the fraction about two-thirds the size of the whole number.

NOTE.—For page numbers, see foot of pages.

## GEOMETRICAL DEFINITIONS

### Volume I, Pages 49-63

IN THIS section are given the geometrical terms used in Mechanical Drawing. It is well to learn the names of the geometrical figures here given because they will be constantly used in the succeeding sections and throughout your drawing studies.

The shapes of these figures must be immediately recognized when the names are given, so that they can be accurately constructed when necessary. The material found on pages 62 and 63 include terms which are used in conjunction with the drawing and the making of gears, as well as in building practice.

### Before Trying to Work the Following Exercises Read Geometrical Definitions, Vol. I, pp. 49-63

1. **Make a sketch of the frustum of a six-sided pyramid.**
2. **Make a sketch of a truncated prism.**
3. **Draw an obtuse-angled triangle.**
4. **Draw a right-angled triangle.**
5. **How many sides has an octagon?**
6. **How many sides has a hexagon?**
7. **How many sides has a pentagon?**

## GEOMETRICAL PROBLEMS

### Volume I, Pages 65-83

IN THESE two sections you are going to study the methods used in the construction of geometrical figures and problems. These constructions will often come up in the drawing work with which you will come in contact in the Drawing Cyclopedia material. A knowledge of these methods of construction will help you to more easily do the drawing as well as cut down on the time consumed in doing the work.

### Before Trying to Work the Following Exercises Read Geometrical Problems, Vol. I, pp. 65-83

It is suggested that the student take each problem as a distinct exercise and draw it in order to get a clear understanding of the method of instruction. This will help you to test the accuracy of your work and give you excellent practice in the use of all your instruments. Extreme care

NOTE.—For page numbers, see foot of pages.

must be taken to see that lines are drawn to exact points of intersection, while dimensions or distances must be carefully laid out, otherwise the problems will not work out correctly.

In doing this work, do not read about the problem and then try to draw it from memory. The best way is to read the instruction carefully to get some idea of what is required and then draw each step of the instruction as you read it a second time.

## SYMBOLS AND CONVENTIONS

### Volume I, Pages 85-98

IT IS often necessary for a draftsman to make new drawings or to make changes on drawings from blueprints or a set of drawings, therefore, he must know the different symbols and conventions used in drafting rooms to be able to read drawings correctly, because certain lines or arrangement of lines means certain things or represent certain material to be used in the manufacture of different objects or machines.

Blue prints are made from tracings, and tracings are either finished in ink on tracing paper or cloth, or made in heavy pencil lines on tracing paper. Drawings that are made with a clean cut or sharp distinction between weights or thicknesses of different classes of lines, not only appear more pleasing to the eye, but they also make blueprints which are much easier to read and understand. Notice the proportional thicknesses of different classes of lines as shown on the first page of this section. Notice the cross-hatch conventions that are used for different kinds of material, and if possible memorize these conventions so that you can recognize the material used as soon as you see the drawing.

The working drawing is a sheet of directions from which the workman makes the object; therefore, it must be properly and fully dimensioned. Arrows should be neatly formed and correctly indicate the points of measurement.

The making or finishing of a drawing in ink calls for great care and neatness in the work. The student should practice making arcs and circles of all sizes with the inking compasses. He should also practice the drawing of straight lines with the T-square and triangles alone and also in conjunction with each other. A careful study of Fig. 15 shows the correct and incorrect method of holding the ruling pen and it will help you to avoid making blots. Study Fig. 13 to see what should be avoided when inking a drawing.

NOTE.—For page numbers, see foot of pages.

The beginner should develop a method of procedure in doing the drawing work which will help him to speed up, and yet enable him to do good work. There is an excellent order of procedure for both pencil and ink work given on pages 97 and 98 of this section.

### Before Trying to Work the Following Exercises Read Symbols and Conventions, Vol. I, pp. 85-98

1. **Draw Fig. 2 on page 87, and put the dimensions on the drawing, taking care to form the arrows as shown under the correct method in Fig. 8.**

2. **Practice drawing fillets and radii as shown in Figs. 9 and 10, and also indicate the radii of the fillet as shown in Fig. 7.**

## PRINCIPLES OF THE WORKING DRAWING

### Volume I, Pages 99-113

IN most cases, the drawing is made first and then the object is made from the drawing. Therefore, before the draftsman can make a drawing he should have a mental picture of the object he is drawing. The shape and construction of the object is presented on the drawing in two views at least. In many cases three views are necessary, and sometimes four, to show the object completely. These views must be definitely located in relation to each other and it is done by the method of orthographic projection.

In this section you will study the principles of projection as applied to the drawing of objects and learn to study the construction of simple objects from definite positions. A thorough understanding of these principles will enable you to read blueprints quickly and thoroughly, because from a glance at one view you will be able to see the shape of the object as it would be seen from one position.

First study the picture or sketch of the object and then study the top and front views placed at the side of the sketch or picture. Be sure to get definitely placed in your mind the positions of the planes of projection in relation to each other and notice the steps used in projecting from one view to another. The projectograph, if made and used, will help you in visualizing the position taken when drawing the different views of an object.

NOTE.—For page numbers, see foot of pages.

### Before Trying to Work the Following Exercises Read Principles of the Working Drawing, Vol. I, pp. 99-113

In each one of these exercises, try to bring to your mind a picture of the object you are drawing and imagine that you are actually looking at the object from the front when drawing the front view and down on the object from above when drawing the top or plan view.

1. **Draw Figs. 2, 4, and 6 on page 100 twice the size shown.**
2. **Draw Figs. 8, 10, 12, and 14 on page 102 twice the size shown.**
3. **Draw Fig. 29, step by step as shown, also twice the size.**

## HIDDEN PARTS AND THIRD VIEW

### Volume I, Pages 115-124

IN the previous section you studied and drew simple objects in which there were no invisible parts such as holes or corners. In this section you will study the drawing of objects in which dotted lines are used. These dotted lines represent hidden portions in or on the object. In studying these drawings, try to imagine that you are looking through the front or top of the object at the invisible portion and it will help you to visualize the positions of these invisible parts in or on the object.

It has been stated that a third view is sometimes necessary to show the shape of the object completely. The side or end view is usually the third view and it will be seen that it is placed to the right and in line with the front elevation. The simple method of projecting and revolving for finding the third view is shown in this section which, if used, will make the drawing of the third view a very simple matter. In considering the end view try to visualize the shape of the object as seen from the right-hand side or end of the object which is in reality the right end of the elevation or front view. Notice that invisible portions are shown in all views.

In doing the exercises suggested for the finding of the third view be sure to use the method and principles shown in Figs. 61 and 62 and explained on pages 121 to 124.

### Before Trying to Work the Following Exercises Read Hidden Parts and Third View, Vol. I, pp. 115-124

1. **Draw Figs. 37, 39, 47, 51, 54, twice the size shown in the illustration.**
2. **Draw Figs. 61 and 62, and last of all draw Fig. 45. Also draw it twice the size shown in the illustration.**

NOTE.—For page numbers, see foot of pages.

## SECTIONS AND DRAWING TO SCALE

### Volume I, Pages 125-135

A LARGE majority of the objects of which drawings are made are too large to be drawn to the actual size. In this section you will learn how to make a drawing to scale. The student should practice the drawing of straight lines and circles to certain definite scales so as to get used to the reading of the scale.

Where the construction of an object is too complicated to be clearly shown in two or three views a section view is shown. This method is especially useful where the construction is such that a large number of dotted lines would have to be used in the different views. A large number of dotted lines very often make the views confusing and a cross section will show the construction much more clearly.

As a simple explanation of a cross section let us consider a loaf of bread that has been cut in half. The portion cut by the knife, if looked at directly, would show a cross section of the loaf. In order to visualize a cross section try to imagine that you have actually taken the object and cut it at a definite point and that you are looking at the portion cut. This will help you to understand much more clearly and quickly what the cross section is.

This part of the drawing work calls for a knowledge of the cross-hatch conventions used for different kinds of material as shown and brought out in a previous section.

In studying the drawing in Fig. 79, it is suggested that the student take the book to a window and study the section as indicated at the top left-hand illustration. Now look at this section as shown to the right of the figure, and then actually study the window construction. If you will do this you will find that a clear understanding of the cross section views will be had. Of course, some of the interior portions of the window will be invisible to your eye as you look at it, but it will show you the relative position of the portions of the window as shown in the section.

### Before Trying to Work the Following Exercises Read Sections and Drawing to Scale, Vol. I, pp. 125-135

1. **Draw a line 6 ft. 6 in. long using the $\frac{1}{2}'' = 1'$ scale, $1\frac{1}{2}'' = 1'$ scale, and $\frac{1}{4}'' = 1'$ scale.**

NOTE.—For page numbers, see foot of pages.

2. **Draw a circle 20′ in diameter, using ½″ = 1′ scale, ⅜″ = 1′ scale, and ⅛″ = 1′ scale.**
3. **Draw Fig. 75 making the drawing twice the size of the figure shown.**
4. **Draw Figs. 76 and 77. See if you can tell by looking at the cross hatching of Fig. 76 what metals are used in its manufacture.**

## WORKING DRAWINGS AND RULES OF PROJECTION

### Volume I, Pages 137-161

THE student should try to develop good habits in the making of his drawings and have a definite form of approach in doing the drawing. To do this he should draw certain lines first and then continue the making of a drawing in a pre-determined way so that the drawing will be rapidly completed. This section gives instructions in the methods of approach.

The principles of projection are based on definite rules and these rules are explained in the section with a series of experiments which should be carried out by the student step by step with the aid of a projectograph. A knowledge of these rules is essential for a clear understanding of projections and it will be found very necessary in the two following sections.

### Before Trying to Answer the Following Questions Read Working Drawings and Rules of Projection, Vol. I, pp. 137-161

Note.—The exercises in this section are in the form of a number of quiz questions.

1. **What are the names of the two planes used in projection work?** (See pages 103 to 109.)
2. See if you can pick out the correct answers to the following question. When the projections of a line are not parallel to the ground line it shows that: (1) **The line is parallel to neither plane of projection.** (2) **The line is oblique to the isometric plane.** (3) **The line is parallel to the horizontal plane.** (4) **Its true length can be found from its projection.** (5) **Its true length can be found by measuring the line.** (6) **Its true length can not be found from its projection.** There are two answers which are correct. (See pages 147 to 161.)
3. **If a line is placed at an angle to the horizontal plane of projection will the projection be shorter than the line, longer than the line, or the same length as the line?** (See pages 147 to 161.)
4. **If the horizontal projection of the line is parallel to the ground line, does it indicate that the line is parallel to the vertical plane or the horizontal plane?** (See pages 147 to 161.)
5. **If the vertical projection of a line is parallel to the ground line, does it indicate that the line is parallel to the horizontal plane or parallel to the vertical plane?** (See pages 147 to 161.)

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6. **In what position is the vertical projection drawn in relation to the horizontal projection?** (See pages 120 to 124.)

7. **What angle of projection is used in the United States?** (See pages 109 to 113.)

8. **Is the vertical projection drawn in the horizontal plane or the vertical plane?** (See pages 109 to 113.)

9. **What view do you see when you look down on the object from above, and what plane of projection is this drawn in?** (See pages 109 to 113.)

10. **What view do you see when you look directly at the object, and what plane of projection is this view drawn in?** (See pages 109 to 113.)

## INTERSECTIONS

### Volume I, Pages 163-181

THERE are many articles constructed out of sheet metal. The shapes are cut out first from sheet metal and then formed and welded to complete the construction. In this type of construction there are many places where different parts intersect. Therefore, if these sheet-metal parts are to be correctly made the shape of the intersections must be carefully laid out on the sheet before the pattern is cut.

In this section you will learn how to project and find the true shapes of intersections. As previously stated the knowledge of projection principles will help you in visualizing the positions of intersecting surfaces in relation to the planes of projection and also enable you to tell whether the true shape can be found from the projections given or whether it will be necessary to apply the principles here taught.

Carefully compare Figs. 9 and 10. These two illustrations will show immediately the difference between a projection and a true shape. Note how each projection has a definite place in the constructing and finding of the true shape of the intersected parts.

In doing the exercises suggested, draw each step of the construction of the figure as you read it.

### Before Trying to Work the Following Exercises Read Intersections, Vol. I, pp. 163-181

1. **Draw Figs. 17, 19, and 20 twice the size shown in the illustration.**

NOTE.—For page numbers, see foot of pages.

## DEVELOPMENT

### Volume I, Pages 183-198

BEFORE a sheet metal object can be made, the pattern must be developed or laid out on the sheet of metal itself, and this must of course be exactly like the developed drawing. The projections of many forms of sheet-metal construction are such that the drawings do not give complete details in regard to shape and size, therefore certain principles or methods must be used to find these true sizes and shapes.

The method of finding the true length of a line, which is sometimes termed the triangulation method, is constantly used to find the correct development which, of course, depends upon the true length or sizes of the object of which the projections are given or first constructed. Learn the rule for finding the true length of the line as given on page 185.

Learn to recognize immediately whether any line in the projection is parallel to the planes of projection from its position in relation to the ground line, for then you can very easily solve the problem of working out a true development.

### Before Trying to Work the Following Exercises Read Development, Vol. I, pp. 183-198

1. Follow out the rule given on page 185, by drawing Figs. 7 and 8 as shown in the text material on pages 184 and 185.
2. Draw Figs. 13 and 14 twice the size of the illustration.
3. Draw Fig. 18 by applying the methods shown in Figs. 15 and 18 inclusive. Draw these figures twice the size.
4. Draw Figs. 22 and 25 twice the size.
5. Draw Fig. 24 twice the size.

## ISOMETRIC PROJECTION

### Volume I, Pages 199-213

THE working drawing is not understood by all mechanics, consequently it is often necessary to present a sketch or picture drawn in such a way that the workmen can readily see the construction of the object. A draftsman can often present his ideas of a design in a much more convincing manner by sketch or picture than by the working drawing, especially when dealing

NOTE.—For page numbers, see foot of pages.

with some one who does not understand projection work. Sometimes it is necessary for a draftsman to make a sketch of some machine part, and then to make a working drawing from that sketch. It will be seen, therefore, that a knowledge of some easy method or principle that can be applied to sketching, or drawing, an object, using mechanical means to do it in pictorial form, would be very useful.

The method of isometric drawing which is based on the drawing of lines in the picture equal in length to those found on the object, provides a simple method of presenting objects in pictorial form.

Learn the method of drawing round objects, and how the true dimensions of the object are used. Note how horizontal dimensions and distances are laid out at 30 degrees, while vertical dimensions are used vertically. Study the working drawings in Fig. 13, and notice the steps that are used to transfer this into isometric drawings.

Note when drawing parts of round objects, such as arcs or parts of circles, the full diameter of the object must be considered when constructing the isometric drawing of the object.

### Before Trying to Work the Following Exercises Read Isometric Projection, Vol. I, pp. 199-213

1. **Draw Fig. 6 exact size and state what the true size of the circles are, of which you have drawn the isometric as represented by the ellipses.** Reference—page 5.
2. **Draw the working drawing shown on page 205 and then construct the isometric. Make this twice the size.**
3. **Draw Fig. 10, making the figure twice the size.**
4. **Draw Figs. 21 and 22, making them twice the size.**
5. **Draw Figs. 23 and 24 twice the size.** In the illustration notice the use of the isometric coordinate line, as indicated by the letters and arrows in Fig. 24.

## OBLIQUE PROJECTION

### Volume I, Pages 215-225

IN OBLIQUE projection you are to learn another method which is mechanical in operation and which can be used for pictorial drawings or sketches. It is well to notice the difference between oblique and isometric. In isometric one corner is nearest

NOTE.—For page numbers, see foot of pages.

to the observer, while in oblique one complete face or side of the object is presented to the observer. Not only do isometric and oblique projections give you new methods of drawing, but they also test your ability to read orthographic or working drawings when transferring these drawings into isometric and oblique.

In this section you will also see some line shading work, which is very seldom used now because of the large amount of time used in doing it.

Carefully study the first angle projection as shown in Figs. 21 and 22, and compare this with the method used in third angle. Note the difference in the position of the views shown.

### Before Trying to Work the Following Exercises Read Oblique Projection, Vol. I, pp. 215-225

1. **Draw Fig. 9 as shown, doing each operation separately and distinctly.**
2. **Draw Figs. 11 and 12, and note the use of the coordinate lines as shown under the corresponding letters in the two views.**

## FREEHAND DRAWING

### Volume I, Pages 227-288

EVERYONE who is interested in drawing should be able to make a freehand sketch, and be able to put his ideas down on paper in pictorial form. In addition to learning the proper materials to use and how to use them, certain rules should be learned so that they will be correctly applied in making the drawing so that it will appear natural to the eye.

Values, with reference to the relation of light and dark, should be understood because a drawing will have life or be flat and uninteresting according to how these values are expressed on the drawings being made.

Before any attempt is made to do any of the suggested exercises, sketches should be made to illustrate and firmly fix the rules in the student's mind. These rules are given on pages 242 to 251. In making these sketches the student should first of all copy those given in the textbook, illustrating the rules, and then he should try to make a sketch of his own, illustrating the rules.

### Before Trying to Work the Following Exercises Read Freehand Drawing, Vol. I, pp. 227-288

1. **Draw Plate 1.** This is for practice in straight line work. This plate should be made according to the measurements given.

NOTE.—For page numbers, see foot of pages.

2. **Draw Plate 2.** This is for practice in simple curves. This plate should be made according to the measurements shown.
3. **Draw Plate 4, Fig. 3.** This figure should be made slightly larger than the illustration shown.
4. **Draw Plate 5, Figs. 2, 3, and 4.** These figures should be drawn twice the size. In drawing these figures no measurements should be taken. The student should judge the correct proportions himself.
5. **Draw Plate 6, Fig. 1.** This figure should be drawn slightly larger than the illustration shown.
6. **Draw Plate 7.** This should be drawn about 1½ times the size shown.
7. **Draw Plate 8.** This plate should be drawn about the same size as the illustration shown.
8. **Draw Plate 10, Fig. 2.** This figure should be drawn slightly larger with all color values shaded in after the outline of the object is carefully completed.

## PERSPECTIVE DRAWING

### Volume I, Pages 289-363

A PERSPECTIVE drawing of an object is a drawing of the object as it appears to the eye. While the student is studying this text he should observe how the principles taught in the section appear to be present in the actual construction of objects he sees around him every day, such as buildings when viewed at a distance, street car tracks, railroads, rectangular shaped objects, etc. This observance will help him to understand the rules of perspective, and their application more readily when drawing the exercises suggested for practice in this section.

Learn how the planes of projection are used, and how the principles of projection must be applied to perspective drawing. Learn the difference between ordinary perspective and one point perspective, for they each have their individual application.

The use of lines of measure is a very important part of perspective work, as the lines of measure are used to give correct proportions to the drawing. To anyone interested in architectural plans, an understanding of perspective plan and application is essential.

### Before Trying to Work the Following Exercises Read Perspective Drawing, Vol. I, pp. 289-363

1. **Draw Fig. 19.** In this drawing make the rectangular blocks 3″ long, 2″ wide, and 1½″ thick. Place the diagram in the position shown in the figure. Place VH 3″ below HPP, and $VH_1$ 3″ below VH. Place the station points as shown in the figure.

NOTE.—For page numbers, see foot of pages.

2. **Draw Fig. 21.** Use the block and its dimensions as given in Exercise 1, having HPP, VH, $VH_1$ in the same relationship as in Exercise 1. Place the front corner of the block 1″ above HPP. **Place the station** points as shown in Fig. 21.
3. **Draw the straight perspective shown in Fig. 22.** Make every dimension of the house and the location of HPP, VH, and $VH_1$ and the station points just twice those shown in Fig. 22.
4. **Draw Fig. 25, making every dimension twice the size shown.**

## ARCHITECTURAL DRAWING

### LETTERING

### Volume II, Pages 11-76

UNLIKE the lettering that is used in mechanical branches of engineering drawing, architectural lettering allows a freedom of line that permits of the individual taste or design of letter being used. It will be seen that the lettering in this section is much more artistic than that previously discussed.

Elevation views, plan views, and section views are used in Architectural Drawing as they are used in mechanical work, but there are terms used by the architect and builder relative to the different parts of a building and its construction which must be learned by the architectural draftsman.

The student will observe that there is a little difference in the technique used in making an architectural drawing, in that the lines at corners and intersections are allowed to overlap slightly. This is the trademark of an architectural draftsman.

Good habits should be formed in the development of drawing. Certain definite steps should be made in proper sequence, so that the completed drawing can be made as quickly and as accurately as possible.

To have a permanent record of drawings without the possibility of damage to the original drawings, tracings are made of the originals from which blueprints are made and the workman constructs the building from the blueprints. Tracing is a very important part of architectural drafting work, and the student is encouraged to practice tracing on tracing cloth and tracing paper as much as possible.

### Before Trying to Work the Following Exercises Read Architectural Drawing—Lettering, Vol. II, pp. 11-76

1. **Make a drawing of Fig. 30 to the scale mentioned on the drawing.**
2. **Make a tracing on tracing cloth of the drawings made for Exercise 1.**

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## ARCHITECTURAL LETTERING

### Volume II, Pages 79-126

IT IS often necessary to letter the name of the building or to place a panel stating some historical fact or inscription on its walls. The lettering should conform to the general style of architecture used in the construction, therefore, the knowledge of the different style of letters is essential as is also the effect of light and shade on different styles of letter construction and the reading of them. In the arrangement of letters for panel construction, good composition and careful arrangement of spacing adds materially to the artistic effect.

The student should practice the different alphabets shown until he is thoroughly familiar with the architectural styles in general use.

**Before Trying to Work the Following Exercises Read Architectural Lettering, Vol. II, pp. 79-126**

1. **Reproduce the panel shown in Fig. 18 to twice the size, using the same style of letters shown in the figure.**
2. **Reproduce the panel in Fig. 18 to twice the size, using the style of capital letters shown on page 105.**

## ARCHITECTURAL DESIGN

### Volume II, Pages 127-260

A SUCCESSFUL architect must know every branch of architecture, every branch of architectural design and building construction so that he can guide and direct all details in an efficient manner. He should, therefore, see that the basic design, drawing, quantity of materials, and building schedules are correct from the start, and see that the details of design such as drawings, etc., are methodically carried out.

The student therefore should study buildings that are completed or in course of construction to familiarize himself with types of architecture, and methods of construction, and good building practice.

He should also study and follow closely the method of procedure from the making of the preliminary sketches to the finished plan, for a well defined process often saves times in eliminating

NOTE.—For page numbers, see foot of pages.

mistakes which are costly to change in drawing and more costly when building work is started.

The outside design or artistic side of building construction is not the only side to be considered. The building must be constructed with sufficient strength, with consideration for the mechanical details that must be installed; and the arrangement of beams, and joists and rafters, while economically installed, must be consistent with strength required. The matter of warmth and radiation must also be taken into account.

Complete specifications as to cost must be compiled and carefully checked before bids are asked for. Throughout this section the student should lay out a logical arrangement of the things he has been studying and try to remember suggestions given from time to time as to the best way to proceed with the problem of architectural design.

### Before Trying to Answer the Following Questions Read Architectural Design, Vol. II, pp. 127-260

1. **What is the first thing to be done by an architect before undertaking the job of building a house?** (See page 155.)
2. **How does the architect present his suggestions to his client?** (See page 162.)
3. **What is meant by a quantity survey?** (See page 147.)
4. **What would you take into consideration when arranging the rooms on the first floor of a small residence?** (See page 157.)
5. **How would you determine the height between floors?** (See page 197.)
6. **What is meant by a framing plan, and what are the three things that must be considered when preparing such a plan?** (See pages 202 to 205.)

## RENDERING IN WASH

### Volume II, Pages 263-321

THE art of rendering in wash is more suitable to architectural subjects than to mechanical. Architects are frequently called upon to show an outside view of the building in perspective. The shadows and high lights in the building can be made to stand out and give life to the drawing by tinting or by rendering the drawing in wash. The secret of good rendering is in knowing how to properly grade the tints so that there is an even graduation with no streaks.

Where color work is done a good knowledge of color combination is necessary.

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**Before Trying to Work the Following Exercise Read**
**Rendering in Wash, Vol. II, pp. 263-321**

1. **Reproduce Fig. 12 and render the drawing in wash using India ink.**

## RENDERING IN PEN AND INK

**Volume II, Pages 323-356**

ANOTHER type of rendering is that done with pen and ink. Although proficiency is difficult of attainment, it is an extremely interesting subject. A great deal of life and color can be given to a drawing that is rendered in pen and ink. Color values are important and they must be obtained by the different arrangement of lines for different tones.

**Before Trying to Work the Following Exercises Read**
**Rendering in Pen and Ink, Vol. II, pp. 323-356**

1. **Make a light pencil sketch of Fig. 17 and then reproduce the tone values as shown in the figure.**
2. **Reproduce Delbury Church.**

## MACHINE DRAWING

### METHODS AND CONVENTIONS

**Volume III, Pages 11-59**

TO BE a successful draftsman it is necessary that the student be thoroughly familiar with, and always remember the things that are important from the shop point of view.

He should present his drawings in the clearest possible way so that the instructions and specifications are clearly and accurately given.

The student should learn the conventions used to indicate certain constructions so that as much time as possible can be saved in the making of the drawing. In this section the student will find useful tables which can be used for reference purposes.

**Before Trying to Work the Following Exercise Read**
**Machine Drawing, Vol. III, pp. 11-59**

1. **Draw the plan and elevation views of a hexagonal headed bolt having 14 threads per inch, S.A.E. standard, with a stem diameter of 1″ and a**

NOTE.—For page numbers, see foot of pages.

**stem length of 3″.** Use Table 3 for reference, and show the bolt using the conventions shown in Figs. 21 and 22, representing the threads using sharp V-thread angle.

## DRAFTING ROOM PRACTICE
### Volume III, Pages 61-88

WORKING drawings consist of assembly drawings and detail drawings, both of which are of equal importance, but individual parts as seen in an assembly drawing do not always give complete instructions to the workman clearly, therefore a separate drawing of all parts used and shown in the assembly drawing must be made, and these are called detail drawings. To do this the student must be able to visualize the shape of the parts of the object from the assembly drawing, and then draw them accordingly.

### Before Trying to Work the Following Exercises Read Drafting Room Practice, Vol. III, pp. 61-88

1. **Study the assembly drawing of the tap wrench shown in Fig. 47 and then draw the details.**
2. **Study the details of the object shown in Fig. 48, and then draw a plan and elevation assembly view.** Try and do this without referring to the plan and sectional elevation views, shown at the left of the drawing.
3. **What size Woodruff key would you use in a shaft having a diameter of 2¼″? Make a drawing of the key actual size.** (See page 88.)

## HELIX AND THREAD CONVENTIONS
### Volume III, Pages 89-103

IN the construction of machines and in their operation, many kinds of mechanisms are used, and many of these mechanisms have a spring or are operated by a spring. Most springs are based on the helix curve, and to correctly design or draw a spring, a thorough understanding of how to construct the helix must be had. Learn what is meant by the lead and pitch of a thread or screw, as applied to the single, double and multiple threads. Note the difference between a compression and extension spring.

### Before Trying to Work the Following Exercise Read Helix and Thread Conventions, Vol. III, pp. 89-103

1. **Reproduce the four steps shown in Fig. 63.**

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## CAMS
### Volume III, Pages 105-159

MANY mechanisms are cam operated. Some are very complicated and some are simple in operation. But whether simple or complicated certain fundamentals must be remembered in the design of them.

In this section the student is taken step by step through the methods used in the drawing of the cam. It is suggested that the student actually draw these figures as the steps are given.

Learn what is meant by uniform motion, accelerated motion, retarded motion, and harmonic motion.

**Before Trying to Work the Following Exercise and Answer the Following Question Read Cams, Vol. III, pp. 105-159**

1. **Reproduce the cylindrical cam given on pages 139 to 151.**
2. **Why is a tapered follower used with a cylindrical cam?** (See page 148.)

## BELTS AND PULLEYS
### Volume III, Pages 161-211

BEFORE the use of individual electric motors for driving machines came into practice, practically all power transmission was accomplished by belts and pulleys. Certain width belts must be used for certain size pulleys for best performance and transmission of power. All belt power transmission is not by straight belts, and where twisted belts are used they must be correctly located and placed on the pulleys.

Learn how to find pulley diameters where speed of shafts are given, and also how to find the correct position for holes through which belts must pass when twisted belt drives are used.

**Before Trying to Answer the Following Questions Read Belts and Pulleys, Vol. III, pp. 161-211**

1. **What is the linear velocity of a belt running on a driving pulley 20″ in diameter and revolving at 500 R.P.M.?** (See page 210.)
2. **What is the R.P.M. of a main shaft pulley when the diameter of the driving pulleys are 20″ and 12″, the diameter of the driven pulleys are 15″ and 18″, and the speed of the main driving pulley is 250 R.P.M.?** (See page 209.)

## GEARS
### Volume III, Pages 213-281

POSITIVE power transmission is obtained by the use of gears. There are different ways of drawing or generating the contour or outline of gear teeth which are discussed in this section

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with some examples given. Formulas have been developed for the calculation of the different portions of gear teeth and it is suggested that you work the examples given in the application of these formulas and also make up some examples of your own for practice.

Learn the names of the different parts of a gear and its teeth. Bevel gears are widely used and formulas have been developed for their calculation, and this also applies to the worm gear as well.

### Before Trying to Work the Following Exercise and to Answer the Following Questions Read Gears, Vol. III, pp. 213-281

1. **Reproduce Fig. 159.**
2. **What is meant by the dedendum circle?** (See page 217.)
3. **What is meant by circular pitch?** (See page 218.)
4. **What is meant by diametral pitch?** (See page 218.)
5. **What is meant by pressure angle?** (See page 219.)
6. **What is the center distance for two spur gears having 60 and 40 teeth with a diametral pitch of 5?** (See page 271.)

## STRUCTURAL DRAFTING

### Volume III, Pages 285-397

STRUCTURAL Drafting pertains to the making of drawings of parts of an object made of steel beams of all kinds which are assembled to form a whole. Drawings made of the steel construction used in buildings would be termed structural drafting. A student should be familiar with all of the terms used in this branch of drafting so that he will know what is meant when these terms are used. Accurate spacing of rivets is important in structural steel work. Certain definite rules must be observed for indicating this spacing on the drawing.

### Before Trying to Answer the Following Questions Read Structural Drafting, Vol. III, pp. 285-397

1. **What is meant by a stress sheet?** (See page 295.)
2. **What is meant by a gauge line?** (See page 330.)
3. **What is meant by the grip of a rivet?** (See page 331.)
4. **If specific instructions are not given for rivet spacing what is the minimum spacing allowed for ¾″ and 1″ rivets?** (See page 329.)
5. **In making a plate girder layout, what details should be observed?** (See page 369.)
6. **Where should the last rivet in a cover plate be in relation to the end of the cover plate?** (See page 385.)

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## SHEET METAL WORK

### Volume IV, Pages 11-276

THE work in sheet-metal pattern drafting calls for a thorough understanding of the principles of projection, as well as the ability to visualize the shape and construction of the object of which the pattern is being drawn. In the study of this branch of drawing the student should keep constantly before him in his mind's eye the position of the planes of projection and their relation to each other, and while studying this section he should try to picture the relationship of the different lines in the projection shown to these planes of projection as he reads about the different examples shown and worked out.

**Before Trying to Work the Following Exercises Read Sheet Metal Work, Vol. IV, pp. 11-276**

1. **Make a pattern drawing of A in Fig. 46.**
2. **Make a pattern out of stiff paper from the drawing given in Exercise 1 and see if the parts fit together correctly.**

## TINSMITHING

### Volume IV, Pages 279-323

WHILE the practical side of tinsmithing would hardly be considered as drafting work there is a great deal of drawing to be done in the actual laying out of the patterns on the sheet metal used in constructing the object.

Great care and accuracy must be used when doing this as one slip in laying out the pattern may result in the whole pattern being spoiled. The student should bear in mind at all times that the object is made from sheet metal. Therefore, the pattern, as laid out, is a development of the object.

**Before Trying to Work the Following Exercises Read Tinsmithing, Vol. IV, pp. 279-323**

1. **Make a drawing and cut out the pattern for a truncated square pyramid as shown in Fig. 15.**
2. **What care must be taken when notching a pattern for wiring or seaming?** (See pages 291 to 292.)
3. **Draw, develop, and cut a pattern similar in construction to Fig. 22. Make the drawing three times the size.** See if you can assemble the funnel from your pattern.

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## SHADES AND SHADOWS

### Volume IV, Pages 325-367

IT IS often necessary for an architect to show a client a picture of the finished building before actual construction takes place. This can be done in perspective but a great deal more realism and better explanation can be given to the perspective drawing if the shades and shadows can be shown as they would be likely to appear, if the actual building stood in the sunlight. Certain rules must be applied and definitions understood by the student to intelligently apply the principles of this study.

**Before Trying to Work the Following Exercise Read Shades and Shadows, Vol. IV, pp. 325-367**

1. **Reproduce Fig. 24 twice the size of the figure shown.**

## BLUEPRINT READING FOR THE BUILDING TRADES

### Volume V, Pages 11-95

TO BE able to read an architectural blueprint quickly and correctly, a thorough knowledge of the terms, symbols, and conventions used in the building trade is necessary, and to any good mechanic or anyone wishing to advance in position and salary a knowledge of blueprint reading is essential. No master mechanic, such as a foreman bricklayer, foreman carpenter, or architect's building superintendent can intelligently direct or check the work of others without knowing how to read a blueprint.

**Before Trying to Work the Following Exercise Read Blueprint Reading for the Building Trades, Vol. V, pp. 11-95**

1. **Read carefully and study the plans spoken of on page 54 and the pages following and note how different sizes and specifications and manner of construction of different parts of the building can be readily picked out on the drawings of plans and elevations given.**

## FREEHAND DRAWING FOR THE MECHANICAL DRAFTSMAN

### Volume V, Pages 97-115

IT IS often necessary for a draftsman to make a sketch of some machine part which is to be replaced because of wear. If the part can be drawn up and made with the least possible loss of machine operating time so much the better. A draftsman

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who can make such a sketch to good proportion and knows how to quickly and carefully make measurements, is helping to cut the cost of production and is, therefore, more valuable than a draftsman who cannot sketch. Such a sketch should be as accurate as possible so that the draftsman to whom it is passed can very easily read it so that he can make working drawings from the sketch.

Freehand sketching is not hard if some simple principles are remembered and this method applied to the work.

**Before Trying to Work the Following Exercises Read Freehand Drawing for the Mechanical Draftsman, Vol. V, pp. 97-115**

1. **Practice making different size circles, using the method shown in Fig. 7.**
2. **Practice drawing straight lines as shown in Fig. 6.**
3. **Sketch the front and top views of the faucet shown in Fig. 13 by applying the method shown in Fig. 14.**
4. **Look around your home and see if there are not many things, as a kettle, table, radio cabinet, etc., which will give you practice in sketching.** Do not measure these objects but sketch them in good proportion.

## BLUEPRINT READING FOR THE MACHINE TRADE

**Volume V, Pages 117-175**

WHEN the words "a good machinist" are used, it brings to mind a man who is not a specialist, that is, a man who can only operate one type of machine. A good machinist is a workman who, when given a blueprint, can read that blueprint and if required make the object shown on the blueprint and do all the necessary machine operations for the job.

One of the highest paid branches of the machinist trade is that of the tool maker and it is also one of the most interesting. One wishing to become a good machinist or good tool maker, or wishing to hold an executive position in a manufacturing plant, must have a knowledge of blueprint reading which is the chief requisition next to that of being a good craftsman.

There are a number of good positions open to men who are able to read blueprints accurately such as chief inspector, foreman of machine shop, etc.

NOTE.—For page numbers, see foot of pages.

**Before Trying to Answer the Following Questions Read Blueprint Reading for the Machine Trade, Vol. V, pp. 117-175**

1. **Answer the quiz questions given on pages 123 to 136.**

# MACHINE DESIGN

## Volume V, Pages 177-333

IF MACHINES are a combination of mechanisms or the application of mechanical forces, then a knowledge of mechanisms is essential to a designer. With this must be included a knowledge of the Strength of Materials, how to calculate the necessary sizes to give the required strength. A designer must also know the methods used in the machine shop, foundry, etc., so that his design can be economically machined or worked so as to maintain the lowest cost of production possible.

A student must learn to study the problems in hand not as one problem but as a series of problems, each of which has a very definite relation or effect on the whole.

The student should work all of the practice problems found at the end of each section, as he finishes reading the material on that particular section.

NOTE.—For page numbers, see foot of pages.